United States
Department of
Agriculture

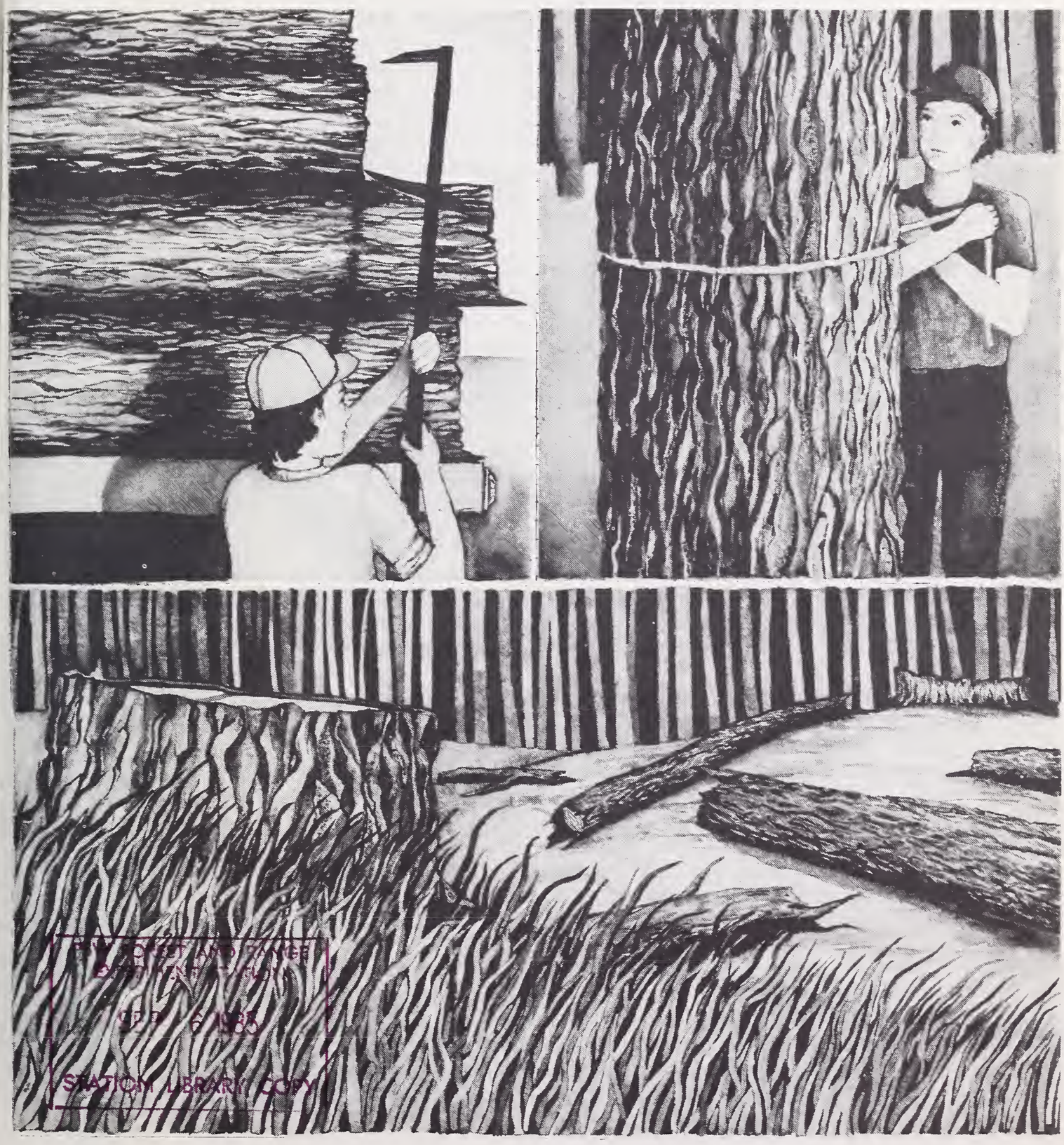
Forest Service

Pacific Northwest
Forest and Range
Experiment Station

Research Paper
PNW-337
May 1985

Comparison of Logging Residue from Lump Sum and Log Scale Timber Sales

James O. Howard and Donald J. DeMars



Authors

JAMES O. HOWARD is a research forester, Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, P.O. Box 3890, Portland, OR 97208. DONALD J. DEMARS is a research forester, Forestry Sciences Laboratory, P.O. Box 909, Juneau, AK 99802.

Abstract

Howard, James O.; DeMars, Donald J. Comparison of logging residue from lump sum and log scale timber sales. Res. Pap. PNW-337. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1985.** 8 p.

Data from 1973 and 1980 logging residues studies were used to compare the volume of residue from lump sum and log scale timber sales. Covariance analysis was used to adjust the mean volume for each data set for potential variation resulting from differences in stand conditions. Mean residue volumes from the two sale types were significantly different at the 5-percent level for the 1973 data but were not significantly different for the 1980 data. These inconclusive findings suggest that the relative efficiency of changing sales procedures should be considered before further study is undertaken.

Keywords: Residues, timber sales, wood utilization.

Summary

Regional timber supplies can be enhanced by increasing utilization from current timber harvest. One way to increase utilization from Federal lands may be to modify timber sale procedures, an option being examined by the USDA Forest Service. Of particular interest is whether lump sum timber sales result in greater utilization than log scale sales. The objective of our study was to determine if a significant difference in timber utilization exists between lump sum and log scale sales in western Oregon.

For the study, logging residue volume was used as an indication of utilization. Data used for the analysis came from two studies conducted in 1973 and 1980 on timberland in western Oregon managed by the USDA Forest Service and the U.S. Department of the Interior, Bureau of Land Management. Differences in residue volume between the two sale methods were tested by multiple covariance analysis; a separate analysis was made for data from each study. Because the data came from different agencies, mean residue volume was adjusted by covariance to account for potential variation attributable to differences in stand conditions.

Analysis of the data consisted of two phases. In the first phase, data on log scale sales were pooled with data from lump sum sales for both the 1973 and 1980 studies. A model was then developed from the stepwise regression fit of the pooled data. The second phase of analysis used covariance techniques to test for significant differences in logging residue volume between the two sale types.

Variance and regression coefficients for the two sale types were not significantly different for either the 1973 or the 1980 data. Results of an F-test indicated that adjusted means of the two sale types were significantly different at the 5-percent level for the 1973 data but were not significantly different for the 1980 data.

The inconclusive nature of these results suggests need for further study. A first step, however, would be to consider the relative efficiency of changing sale procedures, given the small difference shown in this study. An additional consideration is that any difference in utilization between sale types will decrease in the future because of changing technology and resource conditions.

Introduction

A study was conducted to test the common assumption that lump sum and log scale procedures result in different rates of timber utilization. Impetus for the study came from two situations: (1) a general tightening of timber supplies has caused land owners to look for ways to increase the amount of wood available for harvest; and (2) a challenge has directed the USDA Forest Service in the Intermountain, Pacific Southwest, and Pacific Northwest Regions to find ways to increase timber supplies through more effective utilization. The study addresses the latter; specifically, how to increase utilization from existing harvests.

Options available to enhance timber supplies have either long-term or short-term effects. Taking advantage of silvicultural or genetic opportunities will speed up individual tree growth or will increase productivity on existing stands, but gains will be in the future rather than now. An exception providing some flexibility results from the allowable cut effect, an accounting procedure that allows increased harvests today attributable to anticipated future yields from current silvicultural prescriptions. Less flexible are management activities directed at short-term gains. On Federal lands, where timber supplies are regulated by the allowable cut, an option for increasing short-term production is greater utilization from existing timber harvest.

Increases in utilization can result from technological changes in harvesting, marketing, or milling of the timber. The Forest Service is examining timber marketing procedures. In western Oregon, where data for this study were collected, the Forest Service uses log scale sales to market timber. Under this procedure logs removed from a sale are scaled and assessed a value using the average stumpage bid made by the purchaser. Occasionally small logs or cull logs are sold on a per-acre basis and are paid for in lump sum. Such PAM (per-acre material) sales account for only a small portion of the total Forest Service harvest.

Lump sum sales are one alternative to log scale sales. Timber in a lump sum sale is assessed and given a specific value; it is then sold on a lump-sum basis. Thus, scaling the logs removed by the purchaser is not required to establish payment. A commonly held assumption is that the purchaser will remove more material from the sale because a payment is not required for each log taken. A good description of each type of log scale is contained in a report by Brown and others (1982).

The apparent incentive of lump sum selling is centered on smaller or lower quality (marginal) logs. In a log scale sale, a marginal log of equal size and net volume will cost the purchaser the same as a log of higher quality. This situation does not exist in lump sum sales. Hence, the purchaser may be likely to remove marginal logs on lump sum sales, thereby increasing utilization from the sale. At issue, then, is whether the difference in utilization between the two types of sales is real or theoretical. A major question to be answered by the Forest Service is whether utilization would increase from use of lump sum sales procedures. An accompanying issue is whether a change from current sales practices would be cost effective. The latter issue, however, is not within the scope of this paper.

Methods

Data Source

For our study, volume of residual wood on the ground following harvest was used as an indicator of utilization. There were several reasons: (1) Readily accessible data on actual utilization levels[1/] for many sales were not available. (2) Volume measurement techniques for log scaling are somewhat different from techniques used to cruise standing trees. Comparing volumes obtained by both techniques could lead to inconsistent results. (3) The availability of a substantial block of logging residue data, including information on stand characteristics, provided a reasonable approach for the study.

Data used came from two studies conducted in western Oregon in 1973 (Howard 1978) and 1980 (Howard 1981). Ideally the data would have included information for both types of sales from a single agency, but this was not possible. Lump sum sales are not widely used by the Forest Service in western Oregon, and the Bureau of Land Management (BLM), and the U.S. Department of the Interior, does not use log scale procedures. It was therefore necessary to use data from BLM for lump sum sales and data from the Forest Service for log scale sales.

Although data from the two studies were similar, they were not compatible because size standards used to determine logging residue volume were different. For the 1973 study, the minimum size standard was 3.5 inches in diameter inside the bark and at least 4 feet in length. For the 1980 study, the dimensions were 3 inches in diameter and 1 foot in length. Because of the differences, the data were analyzed separately.

The sampling design used to estimate volume of logging residue was the line intersect method (Howard and Ward 1972). For the 1973 and 1980 studies, there were thirty or forty 200-foot transects on a systematic grid on each clearcut. Any logging residue material larger than the minimum size and intersected by a transect line was measured and used to compute the volume of logging residue. Other variables for which estimates were recorded were volume of the stand before cutting, stand defect (1973 data only), size of the cutting unit, stand age, average diameter of the stand, and percent slope.

Analysis

Multiple covariance analysis was used to test for differences in residue volume between the two sale methods; a separate analysis was made for data from the 1973 and 1980 studies. Because the data came from two agencies, mean residue volume was adjusted by covariance to account for potential variation attributable to differences in stand conditions.

[1/] Level of utilization for a specific sale is represented by the volume of timber removed divided by the initial volume offered for sale.

Analysis of the data consisted of two phases. In the first phase, data on log scale sales were pooled with data from lump sum sales for both the 1973 and the 1980 studies. We then developed a model from the stepwise regression fit of the pooled data. The model, based on previous work by Howard (1978), has two forms:

$$Y_{73} = b_{10} + b_{11}x_1^{0.5} + b_{12}x_2^2 + b_{13}x_2^{0.5} + b_{14}x_3^{-1} + b_{15}x_4^{-1} + b_{16}x_4^2, \text{ and}$$

$$Y_{80} = b_{20} + b_{21}x_1^{0.5} + b_{22}x_1^2 + b_{23}x_3^{-1} + b_{24}x_4^{-1} + b_{25}x_4^2;$$

where:

Y_{73}	=	volume of logging residue for 1973, in cubic feet per acre;
Y_{80}	=	volume of logging residue for 1980, in cubic feet per acre;
X_1	=	board foot volume of timber harvested per acre;
X_2	=	average percent of defect in harvested stand;
X_3	=	size of cutting, unit in acres;
X_4	=	stand age of at time of harvest;
$b_{10}, b_{11}, \ldots b_{16}$	=	regression coefficients for 1973 data; and
$b_{20}, b_{21}, \ldots b_{25}$	=	regression coefficients for 1980 data.

The second phase of the analysis used covariance techniques to test for significant differences in logging residue volume between lump sum and log scale sales. The first covariance technique was to test for homogeneity of variance between data sets. If variances were homogeneous, then we determined differences in the shape of the curve forms by testing for significant differences of regression coefficients, either singly or in common. The final covariance technique was to test for different intercepts or adjusted means, a test that was valid only if the data sets were homogeneous and equations described the same curve form.

Results of Analysis

Tables 1 and 2 give statistics for the pertinent covariance analysis of the 1973 and 1980 data. The test for homogeneity of variance for the data sets used a two tailed F test: the larger mean square error for a given year was divided by the smaller and the resulting F value was compared to a tabular value (Snedicor and Cochran 1967) at the 2.5-percent level to obtain a 5-percent test. For the 1973 data, the calculated F value was 1.04, with 72 and 73 degrees of freedom. Because the P value was greater than 0.5 in the two-tailed test, we accepted the hypothesis that the variances were the same. For the 1980 data, the calculated F value was 1.80, with 14 and 10 degrees of freedom, giving P a value of about 0.4 in the two-tailed test. Again, we accepted the hypothesis that the variances were the same.

The test for differences in regression coefficients of the two data sets also employs an F test. For the 1973 data, the F value was 0.83, with 6 and 145 degrees of freedom (table 1). This supports the null hypothesis that there is no difference in the regression coefficients. The test for differences in regression coefficients was not needed for the 1980 data because neither of the individual regressions were significant.

Table 1—Analysis of covariance for data on logging residue from 1973 timber sales in western Oregon

Source	Total		From regression			Error of estimate			
	Degree of freedom	Sum of squares	Degree of freedom	Sum of squares	Mean square	Degree of freedom	Sum of squares	Mean squares	F
Log scale sales	78	242582670	6	75293296	12548883	72	167289373	2323464	5.40 *
Lump sum sales	79	229461162	6	66331909	11055318	73	163129252	2234647	4.95 *
Within						145	330418626	2278749	
Regression coefficient						6	11342355	1890393	0.83 NS
Common	157	472043831	6	130282850	21713808	151	341760981	2263318	
Adjusted means						1	13424090	13424090	5.93 *
Total	158	495496098	6	140311027	23385171	152	355185072	2336744	

* = significant at P $\leq$ 5 percent .
NS = nonsignificant.

Table 2—Analysis of covariance for data on logging residue from 1980 timber sales in western Oregon

Source	Total		From regression			Error of estimate			
	Degree of freedom	Sum of squares	Degree of freedom	Sum of squares	Mean square	Degree of freedom	Sum of squares	Mean squares	F
Log scale sales	19	47682059	5	13591440	2718288	14	34090618	2435044	1.12 NS
Lump sum sales	15	22000778	5	8438878	1687776	10	13561900	1356190	1.24 NS
Within						24	47652519	1985522	
Regression coefficient						5	10627345	2125469	1.07 NS
Common	34	69682837	5	11402974	2280595	29	58279864	2009650	
Adjusted means						1	227392	227392	0.11 NS
Total	35	71591736	5	13084491	2616896	30	58507256	1950242	

NS = nonsignificant.

Table 3—Unadjusted means, adjusted means, and standard error of adjusted means of logging residue volume from timber sales in western Oregon

(In cubic feet per acre)

Source	Unadjusted means	Adjusted means	Standard error of adjusted means
1973 data:			
Log scale sales (Forest Service)	4,387.08	4,322.71	178.12
Lump sum sales (BLM)	3,618.95	3,682.51	176.90
1980 data:			
Log scale sales (Forest Service)	3,580.60	3,467.52	363.41
Lump sum sales (BLM)	3,117.19	3,258.54	418.27

Table 3 gives the unadjusted and adjusted means for logging residue volume. The test for significant differences in the adjusted means of the 1973 data is given in table 1; the F value was 5.93, based on 1 and 151 degrees of freedom. Comparing this value with tabular values shows that the adjusted means are significantly different at the 5-percent level, but are not significantly different at the 1-percent level. The test for significant differences in the adjusted means of the 1980 data (table 2) shows an F value of 0.11, with 1 and 29 degrees of freedom. This test favors the null hypothesis that the adjusted means for the 1980 data are not significantly different.

Discussion

Results of the analysis are inclusive in determining whether there was less logging residue from lump sum sales than from log scale sales. Although mean residue volume was larger for log scale than for lump sum sales (table 3), statistical tests show conflicting results: at the 5-percent level adjusted means are significantly different for the 1973 data but are not significantly different for the 1980 data.

There were reasons for keeping the 1980 data despite the small sample size. First, there was no statistical basis for eliminating the data. The sample seems to be representative with no detectable abnormalities that suggest elimination. Analysis of the values in table 3 show that the large differences between standard error of the mean for 1973 and 1980 is due, in part, to the differences in sample size. Another reason for not discarding the 1980 data is that the results for the 2 years, although different, may be correct. Changes in administrative procedures of timber sales or changes in timber utilization between 1973 and 1980 could account for the apparently conflicting results. The amount of logging residue can be affected greatly by such changes.

It would be somewhat difficult, and beyond the scope of this study, to determine the extent of administrative changes between 1973 and 1980. More can be said, however, about timber utilization. There has been a general trend toward better utilization for many years, brought about by changing yarding standards, greater product diversity, and more efficient harvest technology. Other factors may also have played a role in reducing residue levels. The expected result would be a greater reduction of residue materials where initial volumes were larger. In our study residue volumes in 1973 were greater on Forest Service lands than on BLM lands, and, subsequently incurred the largest decrease by 1980. Table 3 shows that volume of residue on Forest Service lands dropped 806 cubic feet per acre between 1973 and 1980, whereas the decrease on BLM lands was 502 cubic feet. The importance of this reduction is not so much what has occurred, but what will happen in the future. Because of the factors mentioned above and a movement toward harvesting second growth timber, residue levels will continue to decline. As residue volumes decreased, so will the difference between sale types. Also changing will be the characteristics of residue materials. In the future, residue will comprise fewer larger pieces, leaving mostly rotten logs, branches, and tops. But the rotten logs, branches, and tops will most likely be left as residue regardless of which sale procedure is used. Based on all these conditions it is likely that sale type will have a declining impact on residue volume. If this is the case, the issue of sale procedures affecting utilization should be looked at in terms of economic efficiency. A valid question might be: what are the costs of changing timber sale procedures in light of declining differences in residue volumes?

The results of this study are inconclusive and do not demonstrate significant differences in residue volume between lump sum and log scale sales. Two options seem evident from this conclusion. (1) evaluate the relative efficiency of changing from lump sum to log scale sales, based on the magnitude of differences in residue volume displayed in this study; and (2) conduct another study to verify whether the 1980 data is, in fact, representative of the current impact these two sale types have on residue levels. Ideally such a study would be conducted on sales administered by one agency. This is nearly impossible, however, because neither the Forest Service nor BLM use both sale types to any extent within the same geographic area. Therefore we recommended that additional study, if deemed appropriate, follow the design used in this study, using data from numerous sales of each type.

One point to be considered in interpreting the results of this study is the way in which the agencies conduct timber sales. Use of these results in evaluating the impact the two sales have on utilization would be adversely affected if either agency had an inherent advantage in applying one of the sales procedures. We conclude that both agencies would effectively administer either of the sales procedures.

Metric Equivalents

1 inch	=	2.54 centimeters
1 foot	=	30.48 centimeters
1 cubic foot	=	0.028317 cubic meter
1 acre	=	0.4047 hectare

Literature Cited

Brown, Lawrence F.; Craig, Linda S.; Lauch, Paul E.; Buscaglia, Phillip J. Further investigation into constraints and economics of residue collection. Grants Pass, OR: Larry Brown and Associates; **1982**; Interagency Agreement DE-AC79-82BP35756. Not paged. Final report to U.S. Department of Energy, Bonneville Power Administration, Portland, OR.

Howard, James O. A technique for predicting logging residue volumes in the Douglas-fir region. Res. Pap. PNW-225. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1978.** 26 p.

Howard, James O. Ratios for estimating logging residue in the Pacific Northwest. Res. Pap. PNW-288. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1981.** 14 p.

Howard, James O.; Ward, Franklin R. Measurement of logging residue—alternative applications of the line intersect method. Res. Note PNW-183. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1972.** 8 p.

Snedecor, George W.; Cochran, William G. Statistical methods. Ames, IA: Iowa State University Press; **1967** (560-567). 593 p.

Howard, James O.; DeMars, Donald J. Comparison of logging residue from lump sum and log scale timber sales. Res. Pap. PNW-337. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1985.** 8 p.

Data from 1973 and 1980 logging residues studies were used to compare the volume of residue from lump sum and log scale timber sales. Covariance analysis was used to adjust the mean volume for each data set for potential variation resulting from differences in stand conditions. Mean residue volumes from the two sale types were significantly different at the 5-percent level for the 1973 data but were not significantly different for the 1980 data. These inconclusive findings suggest that the relative efficiency of changing sales procedures should be considered before further study is undertaken.

Keywords: Residues, timber sales, wood utilization.

The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

Pacific Northwest Forest and Range
Experiment Station
319 S.W. Pine St.
P.O. Box 3890
Portland, Oregon 97208